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journal or publication title	Journal of Developments in Sustainable Agriculture
volume	9
number	2
page range	111-119
year	2014
URL	http://hdl.handle.net/2241/00125619

Sustainable Agricultural Production Systems for Food Security in a Changing Climate in Batanes, Philippines

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Climate change could have significant impacts in the Philippines on large sections of the population who are poor and vulnerable, especially those who live in areas prone to coastal storms, drought and sea level rise. The sectors mostly affected by climate change are agriculture and food security because of the risk of low productivity due to increasing temperature, drought, and increasing frequency and intensity of rainfall that brings about floods and land-slides.

Located in the northernmost tip of the country, the Batanes group of islands lies on the country's typhoon belt. Because of vulnerability and isolation from the rest of the archipelago, the Ivatans have developed self-sufficient, organic and climate-resilient crop production systems. This paper presents the indigenous crop production systems that have made the Ivatans food self-sufficient despite vulnerability of their agroecosystem.

A typical Ivatan farmer owns 3–7 parcels of land. Each parcel has an average size of 300–500 m². Farmers practice a rootcrop-based multiple cropping system with specific spatial arrangements of corn (*Zea mays*), gabi (*Colocasia esculenta*), yam (*Dioscorea alata*) and tugui (*Dioscorea esculenta*), using corn stover, hardwood trees or a local reed called *viyawu* (*Miscanthus* sp.) as trellis. Banana (*Musa* sp.) and assorted vegetables are planted around the parcels. One to two parcels are planted per season and the rest are left to fallow and used as grazing areas for cattle. The same crops are planted on the other parcels in the next season and the first two parcels utilized will again be planted only after 3–5 years. This unique fallow system maintains soil fertility without the use of chemical fertilizers. They also practice an indigenous storage system that involves hanging of their harvest such as corn, rice, garlic and onion bulbs, even meat and fish, above the firewood-fed cooking area. For generations, the Ivatan farmers' indigenous agricultural production systems have ensured a food security at the household level.

Key words: Batanes, indigenous farming practices, indigenous peoples, Ivatans, sustainable agriculture

1. Introduction

Large fluctuations and variability in climate have serious global impacts in recent years. Developing countries and island states are the most vulnerable to these climatic changes (Yumul *et al.*, 2011; Méheux *et al.*, 2007; Yumul *et al.*, 2008). This is because de-

veloping countries have fewer resources to ensure security of communities despite the impacts of climate change, while island states are vulnerable because of sea-level rise (Yumul *et al.*, 2011).

The Philippines is an archipelagic and developing country. Its geographic location and geological characteristics make it very vulnerable to the impacts of

Received: April 2, 2014, Accepted: June 3, 2014

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changing climate. An average of 20 tropical cyclones enter the Philippine Area of Responsibility (PAR) every year (PAGASA-DOST, 2011), the strongest of which was Typhoon Haiyan which claimed thousands of lives and caused devastating damage to livelihood and property in the central part of the country.

Among the various sectors affected by the increase in climate variability, agriculture and food security, especially in developing countries, are the most threatened. According to the Food and Agriculture Organization (2008), food security exists when all the people at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Food production is threatened by climate change through several ways: increasing temperature and changing rainfall patterns affect crop yield and physiology; inundation in crop-growing areas due to sea-level rise; and extreme rainfall that leads to crop and farm damage (Lasco, 2012). This paper describes the indigenous crop production systems that have made the Ivatans in Batanes, Philippines food self-sufficient despite vulnerability of their agroecosystem.

2. Methodology

Implementers of government-funded research projects on indigenous knowledge (IK) for climate change adaptation identified Batanes as a project site because it is one of the provinces that have long been exposed to the impacts of climate hazards such as typhoons and strong winds. Formal linkage was made with the local government unit of the province through the Provincial Agriculture Office and visits were conducted for the documentation of indigenous climate change adaptation strategies of farmers in Basco, Ivana and Sabtang Island. Actual documentation was done through non-structured interviews of key informants, focused group discussions, and actual observations of the areas and people. Secondary agricultural and climate data were also gathered. Primary and secondary information gathered were collated and summarized and data validation was conducted by presenting the results to the concerned communities.

3. Study Site: Batanes, Philippines

Batanes, the smallest province in the Philippines, is located in the northernmost tip of the country ($20^{\circ}35'30''\text{N}$ $121^{\circ}53'46''\text{E}$) (Fig. 1). Batanes is bound on

the north by the Bashi Channel, on the east by the Pacific Ocean, on the west by the South China Sea and on the south by the Balintang Channel. Basco, its capital town, is approximately 280 km north of Aparri, Cagayan or 860 km north of Manila, and 190 km south of Taiwan (DA-RFO No. 2, 2014).

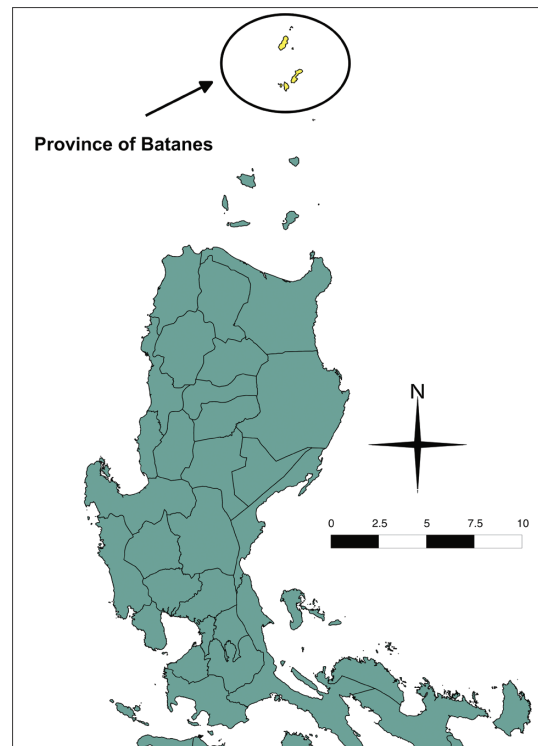


Fig. 1. Map showing the location of Batanes with reference to the mainland of Luzon in the Philippines

The island province is composed of six municipalities and 29 barangays with a total land area of 219.01 km^2 and vast territorial waters of approximately $4,500 \text{ km}^2$. Although Batanes Province is composed of ten islands; only three, Batan, Sabtang and Itbayat are inhabited. Total population of Batanes as of May 2010 (National Statistics Office of the Philippines, 2010) is 16,604, with an average population density of $75 \text{ persons km}^{-2}$. Of the three research sites, Basco has the highest population with 7,907, while Ivana and Sabtang have 1,249 and 1,637, respectively. In terms of topography, Batanes is characterized by rolling hills, steep cliffs and vast grasslands. In 1994, the Island Province of Batanes was declared as one of 10 Integrated Protected Area System (IPAS) sites in the

country (DOT, 2011). The pristine beauty of its surroundings and unique cultural heritage, as well as its proximity to northeast Asian countries enhances its provincial role as “Marine Fisheries and Ecotourism Core” (Provincial Government of Batanes, 2009).

The island province lies at the country’s typhoon belt and is regularly battered by typhoons and strong winds as evidenced by iconic limestone houses that can withstand such natural forces. Basco hosts the last weather station in the northern part of the country, so is always mentioned as a reference point for typhoons as well as weather reports even when typhoons do not cross the province. This may influence the perception that this area is always visited by typhoons (Llanto, 2008).

3.1. The People (Ivatans). The Ivatans are ingenious and highly resilient. Years of being exposed to extreme typhoons with zero casualty prove that they have adapted well to the climate in the area. They are a closely-knit community that highly values integrity and honesty. Crime rate in the area is zero, an indication that the people are peace loving and honest. The province is so small that everyone knows everyone else so they have a strong sense of accountability and responsibility, thus a very strong social control system.

3.2. The Climate. The province of Batanes is classified as a Type II climate under the modified Corona classification system. This climate type is characterized by no dry season and very pronounced maximum rainfall during the last months of the year (PAGASA-DOST, 2011). The Ivatan recognize two seasons: *rayun* (summer), which lasts from March to May and *amian* (winter) from November to February. *Kachachimuyen* are the rainy months for the rest of the year, except for a brief spell of warm weather (*dekey a rayun*) in the two weeks between September and October (Datar, 2011). The mean annual temperature in Batanes is 26.5°C and the mean monthly temperature ranges from 23°C (January) to 29°C (July) (Fig. 2). Precipitation is abundant throughout the year with October having the highest rainfall while April is the driest (World Weather Online, 2014).

The Ivatans have an indigenous indicator of the arrival of a typhoon that is locally called *dumachew* or *mayvulilaw*. When the horizon turns yellowish then disappears, a typhoon is expected to hit the island in 2–3 days. Recently, former Batanes governor, Tele-

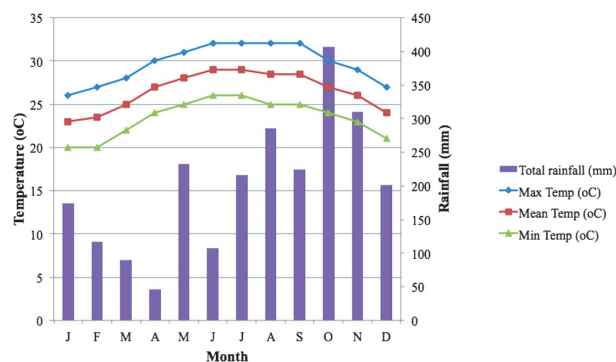


Fig. 2. Meteorological data of Basco, Batanes (World Weather Online, 2014)

sforo Castillejos, was quoted saying that “Climate change seemed to work to the advantage of Batanes. We have not been visited by a strong typhoon in the last 10 years. But if ever, the Ivatans are a resilient people who are used to typhoons” (Basco, 2012). This statement also came out in the discussions with the farmers regarding changes they have observed in climate patterns. According to the farmers, the frequency and intensity of the typhoons have decreased. On the other hand, an increase in temperature has also been observed and they have made adjustments to their work schedules in the farm by working as early as 3:00–4:00 until 8:00 or 9:00 am.

4. Agricultural Production System of the Ivatans

Batanes is an agricultural economy with 5,500 ha of agricultural land. Fishing is another livelihood but only during the months of March to June when the seawater is relatively calm (DOT, 2011). Over centuries of being isolated from the mainland and being regularly battered by typhoons, the locals have developed a sustainable and climate-resilient agricultural system. The Ivatans have a high level of food sufficiency at the household level because each household grows its own food, raises different animals (i.e., chicken, swine and cattle) and have family members who know how to fish.

4.1. Farm lots. Typical Ivatan farmers own between 3–7 parcels of land measuring 300–500 m² per parcel. The borders of the parcel are marked by either a reed called *viyawu* (*Miscanthus* sp.) or trees like *palomaria* (*bitaog*, *Calophyllum inophyllum*) or

bayakbak (local macopa, *Syzygium* sp.). The parcels are strategically located on different sides of the mountain. The planting of crops on different sides acts as a hedge against total crop failure when there is a typhoon because when one side of the mountain is struck by a typhoon and strong winds, crops on the other side survive and provide some yield for the household.

4.2. Crops planted. The major crops of Ivatans are rootcrops like *wakay* (sweet potato, *Ipomoea batatas*), *dukay* (*tugui* or lesser yam, *Dioscorea esculenta*), *uvi* (*ube* or purple yam, *Dioscorea alata*), and *sudi* (*gabi* or taro, *Colocasia esculenta*). These crops are mainly planted for household consumption. The economic yields of these crops, i.e., storage roots, tubers and corms, are underground and are not affected by typhoons. Therefore, they can be grown all year round ensuring household food security.

Rice, corn, sugarcane and various fruits and vegetables are also planted but not in commercial quantities. Rice production declined in the early 1970s when the National Grains Authority constructed a warehouse in Batanes and the province began receiving rice supplies from the mainland. The ready availability of rice changed the Ivatan's diet and the eating habits of the local population away from traditionally grown and nurtured rootcrops (Dayo, 2011).

Sugarcane is planted for the production of vinegar and *palek*, a local wine enjoyed by the Ivatans. Any surplus production is sold in stalls in front of houses or in street corners where pedestrian traffic is high. Only garlic and cattle are produced for the market in mainland Luzon.

4.3. Planting materials. Storage roots, tubers and grains for planting are pre-selected before harvesting and are stored for the next season's planting through methods such as burying in the soil, wrapping in leaves, or placing in jars or canisters. Corn seeds are wrapped in fresh leaves of plants called *rayi*, a foul-smelling wild vine used by elders to cast away evil spirits. It is believed that rubbing the corn seeds against these leaves will prevent rat infestation. The *rayi* leaves are also crushed and mixed with the corn seeds during storage.

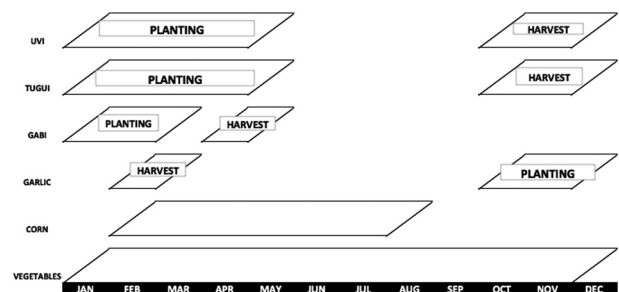
On the other hand, tubers are buried under the soil for 2 or more weeks to cure the cuts and abrasions from



Fig. 3. *Adisan* or special storage area for rootcrops inside an Ivatan house. A Sabtang Island farmer is holding one of the *uvi* tubers being stored in his *adisan*.

the harvesting process. These are then dug up and arranged on a special place in the house called *adisan* (Fig. 3).

4.4. Cropping system. The Ivatans practice root crop-based cropping system: e.g., *tugui*-corn, *tugui*-*gabi*, *gabi*-*tugui*-*uvi*, *gabi*-*tugui*-corn-ginger (Fig. 4). Two types of corn are utilized for intercropping with rootcrops. Glutinous corn is planted in February and harvested in May and yellow corn is planted in April and harvested in July. After harvesting the cobs, the



dried up corn plants are left in the fields and serve as live trellis for the *uvi* and *tugui*. Some vegetables and bananas are also planted in vacant spaces around the utilized parcels of land.

Gabi is simultaneously planted with *uvi* and *tugui* during the first quarter of the year. Since rootcrops shed their leaves at maturity, a specific spatial arrangement of rootcrops and *gabi* was devised by Basco farmers to enable them to dig up and harvest the tubers with little physical damage. Under this system, *gabi* (G) serves as markers for the probable location of *uvi* (U) or *tugui* tubers (Fig. 5).

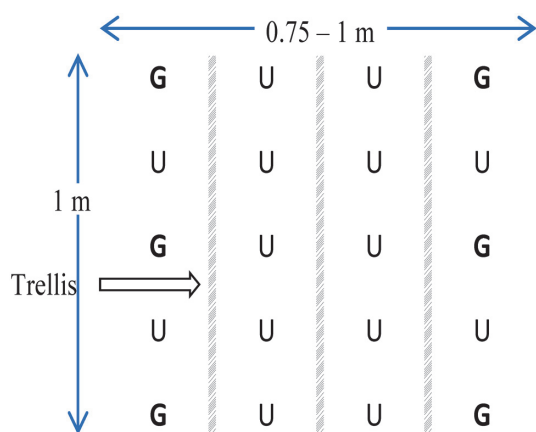


Fig. 5. Spatial arrangement of *gabi* (G) and *uvi* (V) in a 1 m² area in Basco, Batanes

Farmers in Ivana, on the other hand, do not practice this “*gabi*-marker system” and plant their *uvi* or *tugui* at 3 hills m⁻¹. Planting is done from the left side of the field to the right and then down and left after reaching the rightmost boundary of the parcel. Garlic and *gabi* are planted in between rows of *uvi* or *tugui*.

Vegetables are also planted in Batanes with cucurbits, legumes and solanaceous crops planted all year round. Crucifers, on the other hand, are planted during the last quarter of the year when temperatures are low. All year round planting of vegetables in Batanes is a new development and came about only as a result of climate change. The less frequent occurrence and less intense typhoons have enabled Ivatan farmers to produce short duration vegetables anytime of the year. This has greatly contributed to their nutrition and food security.

Since the province is regularly visited by typhoons,

the Ivatans have developed a trellis system that is close to the ground as a protection from being blown away by strong winds. Trellis materials are of four types, i.e., corn (*Zea mays*), *viyawu*, *palomaria*, and a small tree locally called *vius* or *ahas*. *Viyawu* is a reed that is used not only as a trellis (Fig. 6), but also as a live boundary for different parcels of land, windbreak, feed for cattle, roofing material, substitute for wood used in cooking, lighting material for fishermen, material for window blinds, décor, etc. The reed is folded from the ground at about 30 cm and the leaves at the end of the stems are used to bind the next folded reed and so forth. The construction of *viyawu* trellis, which lasts for one half to one day, follows an imaginary straight line from the top going down. Farmers in Ivana usually have a contest on trellis making as a relief for the hard work that it entails.

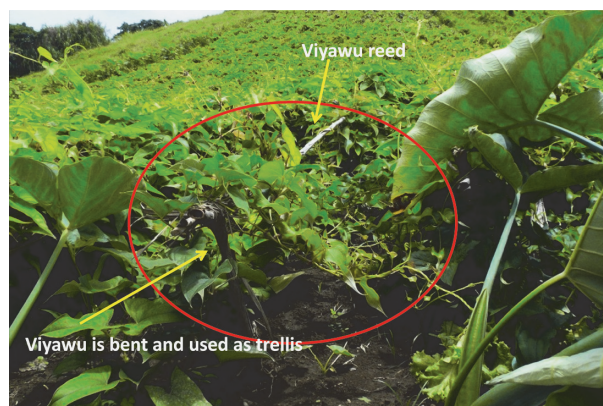


Fig. 6. *Viyawu*, a reed of the *Miscanthus* sp. used as trellis for rootcrops in Batanes farms.

Similar to *viyawu*, *palomaria* also serves a live boundary of different parcels of land. Its fruits have high oil content and are used by fishermen as a source of light. The *palomaria* trellis is utilized in forest areas in Ivana and Sabtang Island. These small trees are felled after the rootcrops have been planted. Leaves and small branches are allowed to drop on the ground adding to the organic matter of the soil. Unlike the *viyawu* trellis, where the *uvi* and *tugui* twine around, in the *palomaria* trellises rootcrops are left to attach to available branches, twigs and trunks of the *palomaria*. *Vius* or *ahas* is utilized as trellis material in the same manner as that of *palomaria*. This is the usual practice in Ivana and Sabtang Island.

4.5. Land Preparation. Rootcrops, rice, corn, vegetables, and banana are planted either in the grasslands of Basco or in the forests of Ivana and Sabtang Island. Land preparation through plowing with the use of draft animals is done before planting in the grasslands of Basco. Zero tillage or no plowing, wherein small trees are felled without burning followed by clearing away of weeds, is practiced in forested areas of Ivana and Sabtang Island. In this swidden agricultural system, seeds or planting material are dibbled into the soil with little or no disturbance to the soil.

4.6. Nutrient management. Crop production in Batanes is basically organic. There are only four farmers in Basco applying chemical fertilizer in corn. Soil fertility is maintained through a unique fallow system wherein one to two parcels are planted in one season while the other parcels are left to fallow. The other parcels are planted the next season and those previously cultivated are left to fallow. This system allows a parcel of land to rest for three to seven years, depending on the number of farm parcels owned by the farmer, allowing it to regain its fertility naturally. Additional nutrients are added in cattle manure collected from outside the parcels or from the manure of cattle that graze freely in the parcels.

Organic agriculture increases soil organic matter content and ensures higher water holding capacity of the soil making crops more resistant to drought conditions (Zamora, 2010). This is especially important under Batanes conditions where agriculture is totally rainfed and where farms are located in sloping areas with high drainage.

Farms in Sabtang Island are located in steep slopes and are terraced for soil and water conservation. Rock walls are built of layered rocks that serve as contour lines. The walls are typically knee-high but height depends on the slope and terrain of the area, i.e., if the farm is steep, higher rock walls are built.

4.7. Pest Management. Hand weeding is done twice and is usually timed during the month of April when there are no classes so the children can help. Rats are managed using mature coconuts, including the husks, as bait. The coconuts, preferred food of the rats, are cut into three parts and distributed around the cornfield at 1 m distances from each other. This is done during the reproductive stage of corn and baits are replaced biweekly.

For the Ivatans, pests (including rats) are managed by choice of varieties and spatial planting. The yam variety for household consumption is planted in the middle of the field, while the variety intended for animal feed is planted in the periphery. This is to ensure that the varieties that are not preferred for human consumption are attacked first by the pests.

The Ivatans avoid agricultural activities during *avayat* (west wind), which occurs between May and August, and where humidity is very high. High humidity is very conducive for the growth and proliferation of microorganisms that cause rapid deterioration of the produce. Also, after planting in a parcel, farmers avoid going to another parcel of land, because they believe they may carry insects or other pathogens that cause diseases and reduce yield.

4.8. Harvesting. The Ivatans are not commercial farmers, and progressive harvesting is a common practice. In this system, the farmers harvest only enough for a week's consumption, and this is repeated on a weekly basis. This progressive method of harvesting works for the farmers and ensures availability of food (mainly root and tuber crops) year round.

4.9. Post-production practices. Harvested seeds, grains, bulbs of garlic and onion, leaves and stems of taro, dried fish and meat, and bundles of rice and corn are hung on top of the cooking area (Fig. 7A). The smoke and heat from the cooking stove aid the preservation of the produce by reducing moisture content to prevent early spoilage. The smoke and heat also drive away insects that cause damage and spoilage. Several types of storage baskets, made of local materials (Fig. 7B) are used for storage of the produce or even cooked food.

5. Sociocultural Dimensions

5.1. Labor. The Ivatan have a closely-knit community wherein labor-sharing is a tradition, not just among family members, but also among peers. There are different types of cooperative work among the Ivatans. The earliest type called the *payuhuan* or exchange of labor (Navarro, 2009) does not involve payment, in cash or in kind. In another type called the *mangju*, a third of the day's harvest goes to the worker, with lunch and snacks provided by the farm owner. The third type, wherein the worker is hired and paid in



Fig. 7. Indigenous storage of harvested produce above the wood-fired cooking area (A) and use of baskets made of local materials for storage of produce and even cooked food (B).

cash, is called *machilangdan*. The daily rate is PhP 250–300 (PhP 43=1 USD) without food.

All the members of the household are involved in farming. The women usually take care of the lighter tasks like weeding, while the children help with farm chores during summer vacation. After work, the Ivatan family members and friends celebrate by getting together and drinking a local wine called *palek*.

5.2. Indigenous rituals and beliefs. The agricultural practices of the Ivatans are deeply rooted in their cultural and religious beliefs. These beliefs have been passed on from older to younger generations. However, at present, not all of the younger farmers follow the beliefs of the elders.

Corn is believed to grow full grains if planted during a full moon or three days after half-moon, except Tuesdays and Fridays. They believe that if planted during Tuesdays and Fridays, the grains will be eaten by a four-legged animal.

Ninety-eight percent of the Ivatans are Roman Catholics. This is evidenced by the existence of a Catholic church in every municipality in the province. Farmers recite Catholic prayers while planting, be-

lieving that this will increase yield and prevent rat infestations.

6. Biodiversity Conservation

Small islands usually have limited carrying capacities. Meager resources have taught the Ivatan to scrimp on every resource available to them. Household food security is the primary concern and no food is wasted. The scarcity of resources have produced food patterns unique to this culture. *Uvud* (banana stalk pith), *vunes* (dried taro stalk), *kudit* (dried cow, carabao, or pig skin), *lunyis* (pork cooked in its own fat), and *arayu* (dried dophinfish, *Coryphaena hippurus*) provide insurance against unexpected food shortages. They are also masters of recycling, few things go to the garbage dump (Datar, 2011).

A special group of fishers, called *mataw*, are the skilled fishers of *arayu*, a migratory non-mammalian dolphin (DENR 2014), also known as *dorado* or *mahi-mahi*. The fishers open the port to catch *arayu* during the fishing season, which starts on the first week of March and ends in May. A ritual called the *kapay-vanuvanuak* is performed to ask the gods for a better catch (Dayo, 2011). No other fishers besides the

mataw can use the port during this season. Another ritual is usually performed at the end of the fishing season. Aside from *dorado* and flying fish (*dibang*), there are several types of fish and other food sources from the sea that also add to the food security of Ivatan households.

Sustainable utilization of various species, endemic or otherwise, has also added to the food self-sufficiency of the Ivatans. In the Sabtang Island, farmers still maintain around 15 different varieties of *uvi*, planting 3–4 varieties every season. They also have 3 varieties of *tugui* that are not clearly distinct from one another.

The *voyavoi* (Philippine date palm, *Phoenix loureiroi*), which is abundant in Sabtang Island, is used as a raw material in the making of *vakul*, a headgear worn by women for protection from sunlight and other elements. It is also used in the making of a gear that is worn on the shoulders of men. The fruits of *voyavoi* are edible, and the leaves are also used to make soft brooms.

There are also several endemic species that add to the list of edible plants in the area: the Batanes lychee called locally as *chayi* and *arius* but more commonly known as the Batanes tree (*Podocarpus costalis*). *Chayi* is a fruit eaten when ripe, while *arius* has a berry-like fruit and is also used as an ornamental plant or as boundaries.

Conclusion and Recommendations

The integrated indigenous farming practices of the Ivatans have proven sustainable through generations. They do not produce crops on a commercial scale, but the indigenous agricultural and food production systems ensure food security in each Ivatan household. The ratio of land area to the population is just enough to maintain the balance in the supply and demand for the crops. A combination of farming, fishing and livestock-raising sustains the availability of food for the community throughout all the seasons.

The Ivatans have unique cropping systems adapted to their local environment. The position of the parcels is oriented in such a way that they are protected from typhoons. They plant root and tuber crops that are adapted to the soil types and terrains of the area. Furthermore, the economic yields of the crops grown are underground and are not affected by strong winds. Multiple cropping systems, characterized by species and varietal diversity, provide hedges against unpre-

dictable and extreme weather conditions.

The harvest and post-harvest storage practices ensure the sustainability of food supplies throughout the year. The practice of organic agriculture, with low or no external inputs, and a social system of labor sharing and non-cash economy contribute to food security.

The important elements of food security, namely, availability, accessibility, utilization and stability of supply of nutritious food, are all present in the Ivatan food production systems, thus making each Ivatan household food secure and self-sufficient.

Acknowledgements

The authors would like to acknowledge the Department of Agriculture-Bureau of Agricultural Research (DA-BAR) for funding the research project entitled 'Documentation of Indigenous Knowledge for Climate Change Adaptation' from which this paper was based. Our deepest gratitude also goes to the people of Batanes, especially the Ivatan farmers who willingly participated and shared their ideas and experiences during the discussions.

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